APPENDIX C
HUMAN HEALTH IMPACTS

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APPENDIX C
HUMAN HEALTH IMPACTS

This appendix contains information in addition to that presented in Chapter 4 on the human health analyses conducted for this environmental impact statement (EIS).

C.1 RADIATION AND HUMAN HEALTH

Radiation is the emission and propagation of energy through space or through a material in the form of waves or bundles of energy called photons, or in the form of high-energy subatomic particles. Radiation generally results from atomic or subatomic processes that occur naturally. The most common kind of radiation is electromagnetic radiation, which is transmitted as photons. Electromagnetic radiation is emitted over a range of wavelengths and energies. We are most commonly aware of visible light, which is part of the spectrum of electromagnetic radiation. Radiation of longer wavelengths and lower energy includes infrared radiation, which heats material when the material and the radiation interact, and radio waves. Electromagnetic radiation of shorter wavelengths and higher energy (which are more penetrating) includes ultraviolet radiation, which causes sunburn, X-rays, and gamma radiation.

Ionizing radiation is radiation that has sufficient energy to displace electrons from atoms or molecules to create ions. It can be electromagnetic (for example, X-rays or gamma radiation) or subatomic particles (for example, alpha and beta radiation). The ions have the ability to interact with other atoms or molecules; in biological systems, this interaction can cause damage in the tissue or organism.

Radioactivity is the property or characteristic of an unstable atom to undergo spontaneous transformation (to disintegrate or decay) with the emission of energy as radiation. Usually the emitted radiation is ionizing radiation. The result of the process, called radioactive decay, is the transformation of an unstable atom (a radionuclide) into a different atom, accompanied by the release of energy (as radiation) as the atom reaches a more stable, lower energy configuration. Radioactive decay produces three main types of ionizing radiation—alpha particles, beta particles, and gamma or X-rays—but our senses cannot detect them. These types of ionizing radiation can have different characteristics and levels of energy and, thus, varying abilities to penetrate and interact with atoms in the human body. Because each type has different characteristics, each requires different amounts of material to stop (shield) the radiation. Alpha particles are the least penetrating and can be stopped by a thin layer of material such as a single sheet of paper. However, if radioactive atoms (called radionuclides) emit alpha particles in the body when they decay, there is a concentrated deposition of energy near the point where the radioactive decay occurs. Shielding for beta particles requires thicker layers of material such as several reams of paper or several inches of wood or water. Shielding from gamma rays, which are highly penetrating, requires very thick material such as several inches to several feet of heavy material (for example, concrete or lead). Deposition of the energy by gamma rays is dispersed across the body in contrast to the local energy deposition by an alpha particle. In fact, some gamma radiation will pass through the body without interacting with it.

Radiation that originates outside of an individual's body is called external or direct radiation. Such radiation can come from an X-ray machine or from radioactive materials (materials or substances that contain radionuclides), such as radioactive waste or radionuclides in soil. Internal radiation originates inside a person's body following intake of radioactive material or radionuclides through ingestion or inhalation. Once in the body, the fate of a radioactive material is determined by its chemical behavior and how it is metabolized. If the material is soluble, it might be dissolved in bodily fluids and transported to and deposited in various body organs; if it is insoluble, it might move rapidly through the gastrointestinal tract or be deposited in the lungs.

Exposure to ionizing radiation is expressed in terms of absorbed dose, which is the amount of energy imparted to matter per unit mass. Often simply called dose, it is a fundamental concept in measuring and quantifying the effects of exposure to radiation. The unit of absorbed dose is the rad. The different types of radiation mentioned above have different effects in damaging the cells of biological systems. Dose equivalent is a concept that considers the absorbed dose and the relative effectiveness of the type of ionizing radiation in damaging biological systems, using a radiation-specific quality factor. The unit of dose equivalent is the rem. In quantifying the effects of radiation on humans, other types of concepts are also used. The concept of effective dose equivalent is used to quantify effects of radionuclides in the body. It involves estimating the susceptibility of the different tissue in the body to radiation to produce a tissue-specific weighting factor. The weighting factor is based on the susceptibility of that tissue to cancer. The sum of the products of each affected tissue's estimated dose equivalent multiplied by its specific weighting factor is the effective dose equivalent. The potential effects from a one-time ingestion or inhalation of radioactive material are calculated over a period of 50 years to account for radionuclides that have long half-lives and long residence time in the body. The result is called the committed effective dose equivalent. The unit of effective dose equivalent is also the rem. Total effective dose equivalent is the sum of the committed effective dose equivalent from radionuclides in the body plus the dose equivalent from radiation sources external to the body (also in rem). All estimates of dose presented in this EIS, unless specifically noted as something else, are total effective dose equivalents, which are quantified in terms of rem or millirem (mrem), which is one one-thousandth of a rem.

More detailed information on the concepts of radiation dose and dose equivalent are presented in publications of the National Council on Radiation Protection and Measurements (NCRP 1993) and the International Commission on Radiological Protection (ICRP 1991).

The factors used to convert estimates of radionuclide intake (by inhalation or ingestion) to dose are called dose conversion factors. The International Commission on Radiological Protection and federal agencies such as the U.S. Environmental Protection Agency (EPA) publish these factors (Eckerman and Ryman 1993; Eckerman et al. 1988). They are based on original recommendations of the International Commission on Radiological Protection (ICRP 1977).

The radiation dose to an individual or to a group of people can be expressed as the total dose received or as a dose rate, which is dose per unit time (usually an hour or a year). Collective dose is the total dose to an exposed population. Person-rem is the unit of collective dose. Collective dose is calculated by summing the individual dose to each member of a population. For example, if 100 workers each received 0.1 rem, the collective dose would be 10 person-rem (100×0.1 rem).

Exposures to radiation or radionuclides are often characterized as being acute or chronic. Acute exposures occur over a short period of time, typically 24 hours or less. Chronic exposures occur over longer periods of time (months to years); they are usually assumed to be continuous over a period, even though the dose rate might vary. For a given dose of radiation, chronic radiation exposure is usually less harmful than acute exposure because the dose rate (dose per unit time, such as rem per hour) is lower, providing more opportunity for the body to repair damaged cells.

On average, members of the public nationwide are exposed to approximately 300 mrem per year from natural sources (NCRP 1987). The largest natural sources are radon-222 and its radioactive decay products in homes and buildings, which contribute about 200 mrem per year. Additional natural sources include radioactive material in the earth (primarily the uranium and thorium decay series, and potassium-40) and cosmic rays from space filtered through the atmosphere. With respect to exposures resulting from human activities, the combined doses from weapons testing fallout, consumer and industrial products, and air travel (cosmic radiation) account for the remaining approximate 3 percent of the total annual dose. Nuclear fuel cycle facilities contribute less than 0.1 percent (0.05 mrem per year) of the total dose.

Cancer is the principal potential risk to human health from exposure to low or chronic levels of radiation. This EIS expresses radiological health impacts as the incremental changes in the number of expected fatal cancers (latent cancer fatalities) for populations and as the incremental increases in lifetime probabilities of contracting a fatal cancer for an individual. The estimates are based on the dose received and on dose-to-health effect conversion factors recommended by the Interagency Steering Committee on Radiation Standards (DOE 2002a). The Committee estimated that, for the general population, a collective dose of 1 person-rem would yield 6×10^{-4} excess latent cancer fatality. For radiation workers, a collective dose of 1 person-rem would yield an estimated 5×10^{-4} excess latent cancer fatality. The higher risk factor for the general population is primarily due to the inclusion of children in the population group, while the radiation worker population includes only people older than 18.

Other health effects such as nonfatal cancers and genetic effects can occur as a result of chronic exposure to radiation. Inclusion of the incidence of nonfatal cancers and severe genetic effects from radiation exposure increases the total detriment by 40 to 50 percent (Table C-1), compared to the change for latent cancer fatalities (ICRP 1991). As is the general practice for any U.S. Department of Energy (DOE) EIS, estimates of the total change have not been included in this EIS.

Table C-1. Risk of Latent Cancer Fatalities and Other Health Effects from Exposure to Radiation

Population	Latent Cancer Fatality (per rem)	Nonfatal Cancer (per rem)	Genetic Effects (per rem)	Total Detriment (per rem)
Workers	4.0×10^{-4}	8.0×10^{-5}	8.0×10^{-5}	5.6×10^{-4}
General Population	5.0×10^{-4}	1.0×10^{-4}	1.3×10^{-4}	7.3×10^{-4}

Source: ICRP 1991.

Exposures to high levels of radiation at high dose rates over a short period (less than 24 hours) can result in acute radiation effects. Minor changes in blood characteristics might be noted at doses in the range of 25 to 50 rad. The external symptoms of radiation sickness begin to appear following acute exposures of about 50 to 100 rad and can include anorexia, nausea, and vomiting. More severe symptoms occur at higher doses and can include death at doses higher than 200 to 300 rad of total body irradiation, depending on the level of medical treatment received. Information on the effects of acute exposures on humans was obtained from studies of the survivors of the Hiroshima and Nagasaki bombings and from studies following a multitude of acute accidental exposures. Factors to relate the level of acute exposure to health effects exist but are not applied in this EIS because expected exposures during normal operations and accidents would be well below 50 rem.

C.2 RADIOLOGICAL ASSESSMENT

When radioactivity is released into the environment, it has the potential to affect persons who come in contact with it. Mechanisms for transporting radiation include air, water, soil and food. The many ways an individual or population can come into contact with radiation are known as pathways. Pathway analysis is useful in quantifying the effective dose equivalent to an individual or population that is affected by the release. If radiation is released into the environment, an individual can come directly into contact with it via the external and inhalation pathways, or indirectly via the ingestion pathway. Submersion in an air or water plume can be directly quantified by dose conversion factors based on the concentration in the medium of interest.

Gaseous effluents released to the atmosphere were modeled with a straight line gaussian plume. The receptors were assumed to be downwind at a location that maximized their dose. The total dose to the individual at that location is the sum of all pathways (external, inhalation, and ingestion). At the location of the receptor, the external dose was calculated by multiplying the time-integrated concentration in air by the length of exposure and then multiplying that product by the appropriate external dose conversion factor for air, for each radionuclide, and then those doses were summed across all radionuclides. Radionuclides deposited on the ground also provide an external dose component and are assessed in a similar manner using the appropriate external ground dose conversion factors.

Internal exposure via inhalation for each radionuclide was quantified at the receptor location by multiplying the estimated concentration of the radionuclide by the intake of air (breathing rate times length of exposure) multiplied by the appropriate inhalation dose conversion factor for all nuclides.

The ingestion pathway is significant for some radionuclides that are released into the air or into water used for irrigation. For those radionuclides in the air, as the plume carrying the radionuclides travels away from the source, the radionuclides are deposited on the ground. Some radionuclides move from the soil into vegetation with water. The outside of plants will also intercept radionuclides from air and water. These plants can be either consumed directly by humans, or ingested by an animal (beef or poultry) that will then be consumed by humans or that will produce milk or eggs. The rates at which radionuclides accumulate in plant and animal product food stuffs are described by radionuclide transfer factors.

The following are pathways for liquid effluents released into surface water. The receptor can come into contact with liquid effluents that are released into surface water through direct external submersion in the contaminated water, boating over contaminated water and by spending time on shorelines where contaminated water is present. These are all external pathways. Internal pathways are primarily from drinking contaminated water, eating fish and wildlife that use the water, and by eating produce and animal products that were irrigated using the contaminated surface water.

C.2.1 Normal Operations

The GENII computer code (Napier et al. 1988) was used to estimate the radiation doses from releases during normal operations. For releases of radioactive material to the atmosphere, two receptors were evaluated: the maximally exposed individual, who was considered to be a nearby resident, and the population within 80 kilometers (50 miles) of the WVDP site. People were assumed to inhale radioactive material and be exposed to external radiation from the radioactive material released during normal operations. People were also assumed to ingest radioactive material through foodstuffs such as leafy vegetables, produce, meat, and milk.

Releases to the atmosphere could be from ground level or from a stack. Annual average atmospheric conditions were used to estimate radiation doses. Site-specific meteorological data from 1994 through 1998 (WVNS 2000a) were used to determine these atmospheric conditions.

The values of parameters used in GENII are listed in Table C-2.

C.2.2 Facility Accidents

The GENII computer code (Napier et al. 1988) was also used to estimate radiation doses from accidents. For accidents where radioactive material would be released to the atmosphere, three receptors were evaluated: (1) a worker at the onsite evaluation point located 640 meters (3,000 feet) from the accident, (2) the maximally exposed individual located at the WVDP site boundary, and (3) the population within

Table C-2. Parameters Used in GENII Radiological Assessments

Parameter	Individual Value	Population Value
Leafy Vegetable Consumption Rate	64 kg/yr	23 kg/yr
Other Produce Consumption Rate	217 kg/yr	80 kg/yr
Fruit Consumption Rate	114 kg/yr	42 kg/yr
Cereal Consumption Rate	125 kg/yr	46 kg/yr
Leafy Vegetable Growing Time	90 d	60 d
Other Produce Growing Time	90 d	60 d
Fruit Growing Time	90 d	60 d
Cereal Growing Time	90 d	60 d
Leafy Vegetable Holdup Time	1 d	14 d
Other Produce Holdup Time	60 d	14 d
Fruit Holdup Time	60 d	14 d
Cereal Holdup Time	90 d	14 d
Leafy Vegetable Yield	2 kg/m^2	2 kg/m^2
Other Produce Yield	2 kg/m^2	2 kg/m^2
Fruit Yield	2 kg/m^2	2 kg/m^2
Cereal Yield	2 kg/m^2	2 kg/m^2
Beef Consumption Rate	73 kg/yr	63 kg/yr
Poultry Consumption Rate	37 kg/yr	31 kg/yr
Milk Consumption Rate	310 L/yr	110 L/yr
Egg Consumption Rate	100 kg/yr	20 kg/yr
Beef Holdup Time	20 d	20 d
Poultry Holdup Time	1 d	1 d
Milk Holdup Time	0 d	4 d
Egg Holdup Time	0 d	3 d
Stored Feed Diet Fraction (beef)	0.25	0.25
Stored Feed Diet Fraction (poultry)	0.25	0.25
Stored Feed Diet Fraction (milk cow)	0.25	0.25
Stored Feed Diet Fraction (laying hen)	0.25	0.25
Stored Feed Grow Time (beef)	90 d	90 d
Stored Feed Grow Time (poultry)	90 d	90 d
Stored Feed Grow Time (milk cow)	45 d	45 d
Stored Feed Grow Time (laying hen)	90 d	90 d
Stored Feed Yield (beef)	2 kg/m^2	1 kg/m^2
Stored Feed Yield (poultry)	2 kg/m^2	2 kg/m^2
Stored Feed Yield (milk cow)	2 kg/m^2	2 kg/m^2
Stored Feed Yield (laying hen)	2 kg/m^2	2 kg/m^2
Stored Feed Storage Time (beef)	90 d	90 d
Stored Feed Storage Time (poultry)	90 d	90 d
Stored Feed Storage Time (milk cow)	90 d	90 d
Stored Feed Storage Time (laying hen)	90 d	90 d
Fresh Forage Diet Fraction (beef)	0.25	0.25
Fresh Forage Diet Fraction (milk cow)	0.75	0.75
Fresh Forage Grow Time (beef)	45 d	45 d
Fresh Forage Grow Time (milk cow)	30 d	30 d
Fresh Forage Yield (beef)	0.70 kg/m^2	2 kg/m^2
Fresh Forage Yield (milk cow)	1 kg/m^2	0.7 kg/m^2
Fresh Forage Storage Time (beef)	90 d	90 d
Fresh Forage Storage Time (milk cow)	0	0
Immersion Exposure Time (Chronic)	8,760 hr/yr	8,760 hr/yr

Table C-2. Parameters Used in GENII Radiological Assessments (cont)

Parameter	Individual Value	Population Value
Inhalation Exposure Time (Chronic)	2,000 hr/yr	2,000 hr/yr
Ground Surface Exposure Time (Chronic)	2,000 hr/yr	2,000 hr/yr
Immersion Exposure Time (Acute)	Duration of plume passage	Duration of plume passage
Inhalation Exposure Time (Acute)	Duration of plume passage	Duration of plume passage
Ground Surface Exposure Time (Acute)	2 hr	2 hr
Mass Loading	1×10^{-4} g/m^3	1×10^{-4} g/m^3
Swimming Time	12 hr/yr	8.3 hr/yr
Boating Time	12 hr/yr	8.3 hr/yr
Other Shoreline Activities Time	12 hr/yr	8.3 hr/yr
Transit Time for aquatic recreation	2.3 hr	0 hr
Irrigation Rate	43 in/yr	36 in/yr
Irrigation Duration	6 mo/yr	6 mo/yr
Fish Consumption Rate	21 kg/yr	0.1 kg/yr
Fish Holdup Time	1 d	10 d
Fish Transit Time	2.3 hr	160 hr
Mixing Ratio	0.125	4×10^{-3}
Average River Flow Rate	13.6 m^3/s	23.1 m^3/s
Transit Time to Irrigation Withdrawal	3.8 hr	0
Drink Water Consumption Rate	0	370 L/yr
Drinking Water Holdup Time	0	1 d
Breathing Rate (Chronic)	270 cm^3/s	270 cm^3/s
Breathing Rate (Acute)	330 cm^3/s	330 cm^3/s

Source: WVNS 2000a.
Acronyms: kg/yr = kilograms per year; d = day; kg/m^2 = kilograms per square meter; L/yr = liters per year; hr/yr = hours per year; g/m^3 = grams per cubic meter; in/yr = inches per year; mo/yr = months per year; m^3/s = cubic meters per second; cm^3/s = cubic centimeters per second

80 kilometers (50 miles) of the WVDP site. The maximally exposed individual was assumed to be at the WVDP site boundary because radiation doses were higher at the boundary than at the actual locations of nearby residents.

People were assumed to inhale radioactive material and be exposed to external radiation from radioactive material released during the accident. This radioactive material could be released from ground level or from a stack, depending on the accident. Two types of atmospheric conditions were used to estimate radiation doses, 50 percent atmospheric conditions and 95 percent atmospheric conditions. Fifty percent atmospheric conditions are conditions that are not exceeded 50 percent of the time and provide a realistic estimate of the likely atmospheric conditions that would exist during an accident. Ninety-five percent atmospheric conditions are conditions that are not exceeded 95 percent of the time and provide an upper bound on the atmospheric conditions that would exist during an accident. Site-specific meteorological data from 1994 through 1998 (WVNS 2000a) were used to determine 50 percent and 95 percent atmospheric conditions.

C.3 RADIONUCLIDE RELEASES FOR NORMAL OPERATIONS

Under all alternatives, it is assumed that current levels of maintenance, surveillance, heating, ventilation, and other routine operations would continue to be required while the actions proposed under each alternative were performed. For this EIS, these actions are called ongoing operations. Because ongoing operations would not vary among the proposed alternatives, the releases from these actions would be the same across all alternatives. These releases are listed in the WVDP Annual Site Environmental Reports for 1995 through 1999 (WVNS 1996, 1997, 1998, 1999a, 2000b). Stack parameters for these releases are listed in Table C-3.

Table C-3. Stack Parameters for Normal Operations Releases

Stack	Height (meters)[a]	Diameter (meters)	Discharge Rate (cubic meters per second)[b]	Exit Velocity (meters per second)
Process Building (ANSTACK)	63.4	1.35	23.6	16.49
Vitrification Facility (ANVITSK)	22.86	0.91	11.8	17.98
Waste Tank Farm (ANSTSK)	10.06	0.47	2.12	12.24
01/14 Building (ANCSSTK)	22.25	0.6	4.58	16.19

Source: WVNS 1999b.
a. To convert meters to feet, multiply by 3.2808.
b. To convert cubic meters to cubic feet, multiply by 0.028317.

C.4 RADIONUCLIDE RELEASES FOR ACCIDENTS

The amount of radioactive material released during an accident is known as the source term. The units of the source term are usually curies. It is the product of several factors, including:

$$\text{Source Term} = \text{MAR} \times \text{DR} \times \text{ARF} \times \text{RF} \times \text{LPF}$$

where:

MAR = Material at risk
DR = Damage ratio
ARF = Airborne release fraction
RF = Respirable fraction
LPF = Leakpath factor

The material at risk is the amount of radioactive material (in grams or curies of radioactivity for each radionuclide) available to be acted on by a given physical stress.

The damage ratio is the fraction of the material at risk impacted by the actual accident-generated conditions under evaluation.

The airborne release fraction is the coefficient used to estimate the amount of a radioactive material that can be suspended in air and made available for airborne transport under a specific set of induced physical stresses. It is applicable to events and situations that are completed during the course of the event.

The respirable fraction is the fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system and is commonly assumed to include particulate matter less than or equal to 10 micrometers in diameter.

The leakpath factor is the fraction of airborne materials transported from containment or confinement deposition or filtration mechanism (for example, fraction of airborne material in a glovebox leaving the glovebox under static conditions, fraction of material passing through a high efficiency particulate air [HEPA] filter).

C.4.1 Class A LLW Drum Puncture

This accident assumed that a drum containing Class A low-level waste (LLW) was punctured during handling by a fork of the forktruck. The accident could take place under the No Action Alternative, Alternative A, or Alternative B.

The material at risk for this accident is based on a Class A LLW drum filled with the intermediate radionuclide mix from Marschke (2001). The values for the damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-4 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-4. Source Term for Class A LLW Drum Puncture

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	6.7×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	6.7×10^{-8}
Cesium-137	8.6×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	8.6×10^{-8}
Plutonium-238	2.7×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	2.7×10^{-8}
Plutonium-239	3.8×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	3.8×10^{-8}
Plutonium-240	2.7×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	2.7×10^{-8}
Plutonium-241	1.1×10^{-2}	0.10	1.0×10^{-3}	1.0	1.0	1.1×10^{-6}
Americium-241	2.8×10^{-5}	0.10	1.0×10^{-3}	1.0	1.0	2.8×10^{-9}
Americium-243	8.3×10^{-7}	0.10	1.0×10^{-3}	1.0	1.0	8.3×10^{-11}
Curium-244	4.0×10^{-7}	0.10	1.0×10^{-3}	1.0	1.0	4.0×10^{-11}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.2 Class A LLW Pallet Drop

This accident assumed that a pallet containing six Class A LLW drums was dropped during handling and the 6 drums were punctured. The accident could take place under the No Action Alternative, Alternative A, or Alternative B.

The material at risk for this accident is based on a Class A LLW drum filled with the intermediate radionuclide mix from Marschke (2001). The values for the damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-5 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-5. Source Term for Class A LLW Pallet Drop

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	4.0×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	4.0×10^{-7}
Cesium-137	5.2×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	5.2×10^{-7}
Plutonium-238	1.6×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	1.6×10^{-7}
Plutonium-239	2.3×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	2.3×10^{-7}
Plutonium-240	1.6×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	1.6×10^{-7}
Plutonium-241	0.063	0.10	1.0×10^{-3}	1.0	1.0	6.3×10^{-6}
Americium-241	1.7×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	1.7×10^{-8}
Americium-243	5.0×10^{-6}	0.10	1.0×10^{-3}	1.0	1.0	5.0×10^{-10}
Curium-244	2.4×10^{-6}	0.10	1.0×10^{-3}	1.0	1.0	2.4×10^{-10}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.3 Class A LLW Box Puncture

This accident assumed that a B-25 box containing 90 cubic feet of Class A LLW was punctured during handling by a fork of the forktruck. The accident could take place under the No Action Alternative, Alternative A, or Alternative B.

The material at risk for this accident is based on a Class A LLW box filled with the intermediate radionuclide mix from Marschke (2001). The values for the damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-6 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-6. Source Term for Class A LLW Box Puncture

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	8.3×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	8.3×10^{-7}
Cesium-137	0.011	0.10	1.0×10^{-3}	1.0	1.0	1.1×10^{-6}
Plutonium-238	3.3×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	3.3×10^{-7}
Plutonium-239	4.6×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	4.6×10^{-7}
Plutonium-240	3.3×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	3.3×10^{-7}
Plutonium-241	0.13	0.10	1.0×10^{-3}	1.0	1.0	1.3×10^{-5}
Americium-241	3.4×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	3.4×10^{-8}
Americium-243	1.0×10^{-5}	0.10	1.0×10^{-3}	1.0	1.0	1.0×10^{-9}
Curium-244	4.9×10^{-6}	0.10	1.0×10^{-3}	1.0	1.0	4.9×10^{-10}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.4 Collapse of Tank 8D-2 Vault (Wet)

For this accident, it is assumed that the occurrence of a severe earthquake greater than six times the design basis (0.1 g) causes the roof of Tank 8D-2 and its vault to collapse, exposing the tank contents to the atmosphere. In this accident, the contents of the tank were assumed to be wet. The material at risk for

Tank 8D-2 was a heel made up of two components, the mobile inventory and the fixed inventory (WVNS 2001a). The mobile inventory consisted of the liquid at the bottom of the tank. This liquid was assumed to have an airborne release fraction of 1×10^{-8}. The fixed inventory was assumed to be scoured from the sides of the tank by debris falling into the tank during the collapse and have an airborne release fraction of 1×10^{-7}. Because of its physical form (particles as opposed to liquid), the zeolite inventory was assumed to not be released during the accident.

This accident could take place under any of the alternatives. The frequency of this accident was estimated to be in the range of 10^{-4} to 10^{-6} per year (WVNS 2002a). Table C-7 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-7. Source Term for Tank 8D-2 Collapse (Wet)

Nuclide	Mobile MAR (curies)	Fixed MAR (curies)	DR	Mobile ARF	Fixed ARF	RF	LPF	ST (curies)
Carbon-14	1.0×10^{-3}	4.0×10^{-3}	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	4.1×10^{-10}
Cobalt-60	0.50	1.2	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.3×10^{-7}
Nickel-63	4.1	9.7	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.0×10^{-6}
Strontium-90	820	39,000	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	3.9×10^{-3}
Technetium-99	0.12	0.68	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	6.9×10^{-8}
Cesium-137	21,000	4,600	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	6.7×10^{-4}
Plutonium-241	6.3	1,000	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.0×10^{-4}
Curium-242	0.060	1.4	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.4×10^{-7}
Neptunium-237	7.0×10^{-3}	0.32	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	3.2×10^{-8}
Plutonium-238	0.70	120	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.2×10^{-5}
Plutonium-239	0.30	48	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	4.8×10^{-6}
Americium-241	5.4	170	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.7×10^{-5}
Americium-243	0.090	2.1	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	2.1×10^{-7}
Curium-244	1.1	25	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	2.5×10^{-6}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.5 Collapse of Tank 8D-2 Vault (Dry)

For this accident, it is assumed that the occurrence of a severe earthquake greater than six times the design basis (0.1 g) causes the roof of Tank 8D-2 and its vault to collapse, exposing the tank contents to the atmosphere. In this accident, the contents of the tank were assumed to be dry. The material at risk for Tank 8D-2 was a heel made up of two components, the mobile and zeolite inventory, and the fixed inventory (WVNS 2001a). The mobile and zeolite inventory was assumed to have dried out at the bottom of the tank. This dry material was assumed to have an airborne release factor of 4×10^{-7}. The fixed inventory was assumed to be scoured from the sides of the tank by debris falling into the tank during the collapse and have an airborne release factor of 1×10^{-7}.

Two phenomena were assumed to control the release of radioactive material following a tank collapse. The impact stresses imposed by the falling debris entrain some of the radioactive material in the air during the collapse. For the material on the walls of the tank, the fraction airborne was estimated using Equation 5-1 in DOE (1994). Using a fall height of 8 meters (27 feet) and a particle density of 2 grams per cubic meter, an airborne release fraction of 3×10^{-5} was estimated.

For the solid debris on the bottom of the tank, Section 4.4.3.3.2 of DOE (1994) summarizes experiments that have been run to estimate the release fractions when debris falls into various powders. According to Volume 2 of DOE (1994), there is only one experiment in which objects were actually dropped on powders; Table A-42 of that document summarizes those results. Based on the values listed in the "< 10 :m Inhal. PMS Probe" column, the average airborne release fraction is 1.4×10^{-4}.

The two airborne release fractions derived above were multiplied by 3×10^{-3} to obtain the final release fractions of 1.0×10^{-7} and 4×10^{-7}. The factor of 3×10^{-3} accounts for the effectiveness of the falling debris to remove entrained respirable particulates. The basis for this removal fraction is a series of experiments performed to determine the release fraction of respirable material following an explosion in a cell used to assemble nuclear weapons. These cells have roofs consisting of several feet of overburden that falls into the cell following an explosion. These experiments show that the falling debris removes 99.7 percent of the respirable particles.

This accident could take place under any of the alternatives. The frequency of this accident was estimated to be in the range of 10^{-4} to 10^{-6} per year (WVNS 2002a). Table C-8 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-8. Source Term for Tank 8D-2 Collapse (Dry)

Nuclide	Dry MAR (curies)	Fixed MAR (curies)	DR	Dry ARF	Fixed ARF	RF	LPF	ST (curies)
Carbon-14	1.0×10^{-3}	4.0×10^{-3}	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	8.0×10^{-10}
Cobalt-60	0.50	1.2	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	3.2×10^{-7}
Nickel-63	4.1	9.7	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	2.6×10^{-6}
Strontium-90	990	39,000	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	4.3×10^{-3}
Technetium-99	0.12	0.68	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	1.2×10^{-7}
Cesium-137	130,000	4,600	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	0.054
Plutonium-241	8.3	1,000	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	1.0×10^{-4}
Curium-242	0.060	1.4	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	1.6×10^{-7}
Neptunium-237	7.0×10^{-3}	0.32	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	3.5×10^{-8}
Plutonium-238	0.93	120	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	1.2×10^{-5}
Plutonium-239	0.40	48	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	5.0×10^{-6}
Americium-241	5.4	170	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	1.9×10^{-5}
Americium-243	0.090	2.1	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	2.4×10^{-7}
Curium-244	1.1	25	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	2.9×10^{-6}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.6 Drum Cell Drop

This accident assumed that two drums containing solidified LLW from the Drum Cell were dropped. The accident could take place under Alternative A or Alternative B.

The material at risk for this accident is based on a 71-gallon drum filled with solidified LLW (WVNS 1993b). The airborne release fraction (DOE 1994) assumed that the cement in the drum was solid with a density of 1.8 grams per cubic centimeter (0.065 pound per cubic inch). The fall height for the drums was assumed to be 200 centimeters (79 inches), which yields an airborne release fraction of 7.1×10^{-6}. The damage ratio, respirable fraction, and leakpath factor were assumed to equal one for this accident. The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-9 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-9. Source Term for Drum Cell Drop

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	0.30	1.0	7.1×10^{-6}	1.0	1.0	2.1×10^{-6}
Cesium-137	2.0	1.0	7.1×10^{-6}	1.0	1.0	1.4×10^{-5}
Plutonium-238	0.076	1.0	7.1×10^{-6}	1.0	1.0	5.4×10^{-7}
Plutonium-239	0.015	1.0	7.1×10^{-6}	1.0	1.0	1.0×10^{-7}
Plutonium-240	0.011	1.0	7.1×10^{-6}	1.0	1.0	7.8×10^{-8}
Plutonium-241	0.74	1.0	7.1×10^{-6}	1.0	1.0	5.2×10^{-6}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.7 Class C LLW Drum Puncture

This accident assumed that a drum containing Class C LLW was punctured during handling by a fork of the forktruck. The accident could take place under Alternative A or Alternative B.

The material at risk, damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-10 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-10. Source Term for Class C LLW Drum Puncture

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	0.14	0.10	1.0×10^{-3}	1.0	1.0	1.4×10^{-5}
Cesium-137	0.15	0.10	1.0×10^{-3}	1.0	1.0	1.5×10^{-5}
Plutonium-238	7.5×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	7.5×10^{-7}
Plutonium-239	2.1×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	2.1×10^{-7}
Plutonium-240	1.5×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	1.5×10^{-7}
Plutonium-241	0.099	0.10	1.0×10^{-3}	1.0	1.0	9.9×10^{-6}
Americium-241	5.7×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	5.7×10^{-7}
Americium-243	5.0×10^{-5}	0.10	1.0×10^{-3}	1.0	1.0	5.0×10^{-9}
Curium-244	6.0×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	6.0×10^{-8}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.8 Class C LLW Pallet Drop

This accident assumed that a pallet containing six Class C LLW drums was dropped during handling and the 6 drums were punctured. The accident could take place under Alternative A or Alternative B.

The material at risk, damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-11 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-11. Source Term for Class C LLW Pallet Drop

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	0.84	0.10	1.0×10^{-3}	1.0	1.0	8.4×10^{-5}
Cesium-137	0.90	0.10	1.0×10^{-3}	1.0	1.0	9.0×10^{-5}
Plutonium-238	0.045	0.10	1.0×10^{-3}	1.0	1.0	4.5×10^{-6}
Plutonium-239	0.013	0.10	1.0×10^{-3}	1.0	1.0	1.3×10^{-6}
Plutonium-240	9.0×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	9.0×10^{-7}
Plutonium-241	0.59	0.10	1.0×10^{-3}	1.0	1.0	5.9×10^{-5}
Americium-241	0.034	0.10	1.0×10^{-3}	1.0	1.0	3.4×10^{-6}
Americium-243	3.0×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	3.0×10^{-8}
Curium-244	3.6×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	3.6×10^{-7}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.9 Class C LLW Box Puncture

This accident assumed that a B-25 box containing 90 cubic feet of Class C LLW was punctured during handling by a fork of the forktruck. The accident could take place under Alternative A or Alternative B.

The material at risk, damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-12 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-12. Source Term for Class C LLW Box Puncture

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	1.4	0.10	1.0×10^{-3}	1.0	1.0	1.4×10^{-4}
Cesium-137	1.5	0.10	1.0×10^{-3}	1.0	1.0	1.5×10^{-4}
Plutonium-238	0.075	0.10	1.0×10^{-3}	1.0	1.0	7.5×10^{-6}
Plutonium-239	0.021	0.10	1.0×10^{-3}	1.0	1.0	2.1×10^{-6}
Plutonium-240	0.015	0.10	1.0×10^{-3}	1.0	1.0	1.5×10^{-6}
Plutonium-241	0.99	0.10	1.0×10^{-3}	1.0	1.0	9.9×10^{-5}
Americium-241	0.057	0.10	1.0×10^{-3}	1.0	1.0	5.7×10^{-6}
Americium-243	5.0×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	5.0×10^{-8}
Curium-244	6.0×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	6.0×10^{-7}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.10 High-Integrity Container Drop

This accident assumed that a high-integrity container holding radioactive sludge and resin was dropped during handling, spilling its contents. The accident could take place under Alternative A or Alternative B.

The material at risk, damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (2002a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-13 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-13. Source Term for High-Integrity Container Drop

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Americium-241	0.18	1.0	4.0×10^{-5}	1.0	1.0	7.2×10^{-6}
Plutonium-239	0.15	1.0	4.0×10^{-5}	1.0	1.0	6.1×10^{-6}
Plutonium-240	0.12	1.0	4.0×10^{-5}	1.0	1.0	4.6×10^{-6}
Plutonium-241	5.7	1.0	4.0×10^{-5}	1.0	1.0	2.3×10^{-4}
Plutonium-238	0.043	1.0	4.0×10^{-5}	1.0	1.0	1.7×10^{-6}
Cesium-137	210	1.0	4.0×10^{-5}	1.0	1.0	8.4×10^{-3}
Cobalt-60	5.2	1.0	4.0×10^{-5}	1.0	1.0	2.1×10^{-4}
Strontium-90	2.2	1.0	4.0×10^{-5}	1.0	1.0	8.7×10^{-5}
Cesium-134	4.5	1.0	4.0×10^{-5}	1.0	1.0	1.8×10^{-4}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.11 CH-TRU Drum Puncture

This accident assumed that a drum containing contact-handled transuranic (CH-TRU) waste was punctured during handling by a fork of the forktruck. The accident could take place under Alternative A or Alternative B.

The material at risk for this accident is from WVNS (2002a). The damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-14 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-14. Source Term for CH-TRU Drum Puncture

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Plutonium-238	3.3	0.10	1.0×10^{-3}	1.0	1.0	3.3×10^{-4}
Strontium-90	520	0.10	1.0×10^{-3}	1.0	1.0	0.052
Plutonium-239	0.85	0.10	1.0×10^{-3}	1.0	1.0	8.5×10^{-5}
Plutonium-240	0.64	0.10	1.0×10^{-3}	1.0	1.0	6.4×10^{-5}
Americium-241	0.62	0.10	1.0×10^{-3}	1.0	1.0	6.2×10^{-5}
Plutonium-241	32	0.10	1.0×10^{-3}	1.0	1.0	3.2×10^{-3}
Curium-244	0.14	0.10	1.0×10^{-3}	1.0	1.0	1.4×10^{-5}
Americium-243	0.045	0.10	1.0×10^{-3}	1.0	1.0	4.5×10^{-6}
Cesium-137	570	0.10	1.0×10^{-3}	1.0	1.0	0.057
Uranium-232	0.015	0.10	1.0×10^{-3}	1.0	1.0	1.5×10^{-6}
Americium-242m	7.6×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	7.6×10^{-7}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.12 Fire in Loadout Bay

This accident involved a diesel fuel fire in the Remote-Handled Waste Facility as a result of a leak in the fuel tank or fuel line of a truck. This fire would involve CH-TRU and remote-handled transuranic (RH-TRU) waste. The frequency of this accident was estimated to be in the range of 10^{-4} to 10^{-6} per year WVNS (2000c). This accident could take place under Alternative A or Alternative B.

The material at risk, damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (2000c). Table C-15 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-15. Source Term for Fire in Loadout Bay

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Plutonium-238	11	1.0	6.0×10^{-3}	0.010	1.0	6.8×10^{-4}
Americium-241	3.9	1.0	6.0×10^{-3}	0.010	1.0	2.3×10^{-4}
Plutonium-239	3.2	1.0	6.0×10^{-3}	0.010	1.0	1.9×10^{-4}
Plutonium-240	2.4	1.0	6.0×10^{-3}	0.010	1.0	1.5×10^{-4}
Plutonium-241	71	1.0	6.0×10^{-3}	0.010	1.0	4.2×10^{-3}
Cesium-137	180	1.0	6.0×10^{-3}	1.0	1.0	11
Strontium-90	170	1.0	6.0×10^{-3}	0.010	1.0	9.9×10^{-3}
Curium-244	0.35	1.0	6.0×10^{-3}	0.010	1.0	2.1×10^{-5}
Americium-243	0.17	1.0	6.0×10^{-3}	0.010	1.0	1.0×10^{-5}
Uranium-232	0.051	1.0	6.0×10^{-3}	0.010	1.0	3.0×10^{-6}
Americium-242	0.027	1.0	6.0×10^{-3}	0.010	1.0	1.6×10^{-6}
Thorium-228	0.051	1.0	6.0×10^{-3}	0.010	1.0	3.1×10^{-6}
Americium-242m	0.027	1.0	6.0×10^{-3}	0.010	1.0	1.6×10^{-6}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.5 ATMOSPHERIC DATA

Hourly meteorological data collected at West Valley are shown in Tables C-16 and C-17 for 10-meter (33-foot) and 60-meter (197-foot) heights. These data were collected over a 5-year period from 1994 through 1998 (WVNS 2000a). They are arranged according to direction, atmospheric stability class, and wind speed. When the wind was calm (wind speed = 0 meters per second), the data were assigned to stability classes weighted by the frequency of each stability class. The "greater than 12 meters per second" data were included with the "9.0-12.0 meters per second" data.

C.6 LOCATIONS OF RECEPTORS

Locations of receptors near the WVDP site are listed in Table C-18. To provide a realistic estimate of maximally exposed individual radiation doses from airborne releases during normal operations, radiation doses were evaluated at the locations of nearby residences. For releases from the Process Building, the location that yielded the largest radiation dose was at 1,800 meters (5,900 feet) northwest of the WVDP site. For airborne releases from the Vitrification Facility, the Waste Tank Farm, and the 01/14 Building, the location that yielded the largest radiation dose was at 1,900 meters (6,200 feet) north-northwest of the WVDP site. Population radiation doses from airborne releases during normal operations included contributions from all directions for distances from 0 to 80 kilometers (0 to 50 miles) of the WVDP site.